

State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

STANDING STOCKS OF FISHES IN SECTIONS
OF INDIAN CREEK, PLUMAS COUNTY, 1987

Bay-Delta Project
Contract Services Section

By

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INTRODUCTION

In 1976, the Department of Water Resources (DWR) initiated an instream flow program to identify streams that would benefit from flow enhancement to assess instream values and identify trade-offs required to enhance these streams. The Northern District of DWR selected Indian Creek below Antelope Reservoir (Figure 1) as one of the streams to study under this program. Initial flow studies by DWR indicated that flow augmentation could double trout habitat in the first 16 km of Indian Creek below the dam and increase habitat by 25% in lower reaches (DWR, 1979). As a result of this study, DWR and the Department of Fish and Game (DFG) decided to reoperate Antelope Reservoir to increase flow releases from 0.1 cms to 0.6 cms year-round on a trial basis. These flows would not impair recreation at Antelope Reservoir.

In 1977, sampling of salmonids was begun in Indian Creek at six different stations. Sampling continued through 1982 on a yearly basis to provide base-line data for salmonid biomasses. The biomasses peaked in 1980 for both brown trout (Salmo trutta) and rainbow trout (Oncorhynchus mykiss). Brown biomass for all fish caught was 6.0 g/m², catchables averaged 5.5 g/m² for six stations, rainbow trout averaged 4.4 g/m² and 1.7 g/m² for all rainbow trout caught and catchables at four stations, respectively (Brown 1978, Brown and Haines 1979, Haines and Brown 1980, Villa and Brown 1981, Villa 1982). Fish were not sampled in 1983, 1984, or 1985. Sampling resumed in 1986. The biomass for brown trout in 1986 was 2.5 g/m² for both catchables and all fish caught. Rainbow trout averaged 1.1 g/m² for all fish caught and 2.5 g/m² for catchables, those >127 mm fork length (Bumpass and Smith, 1987).

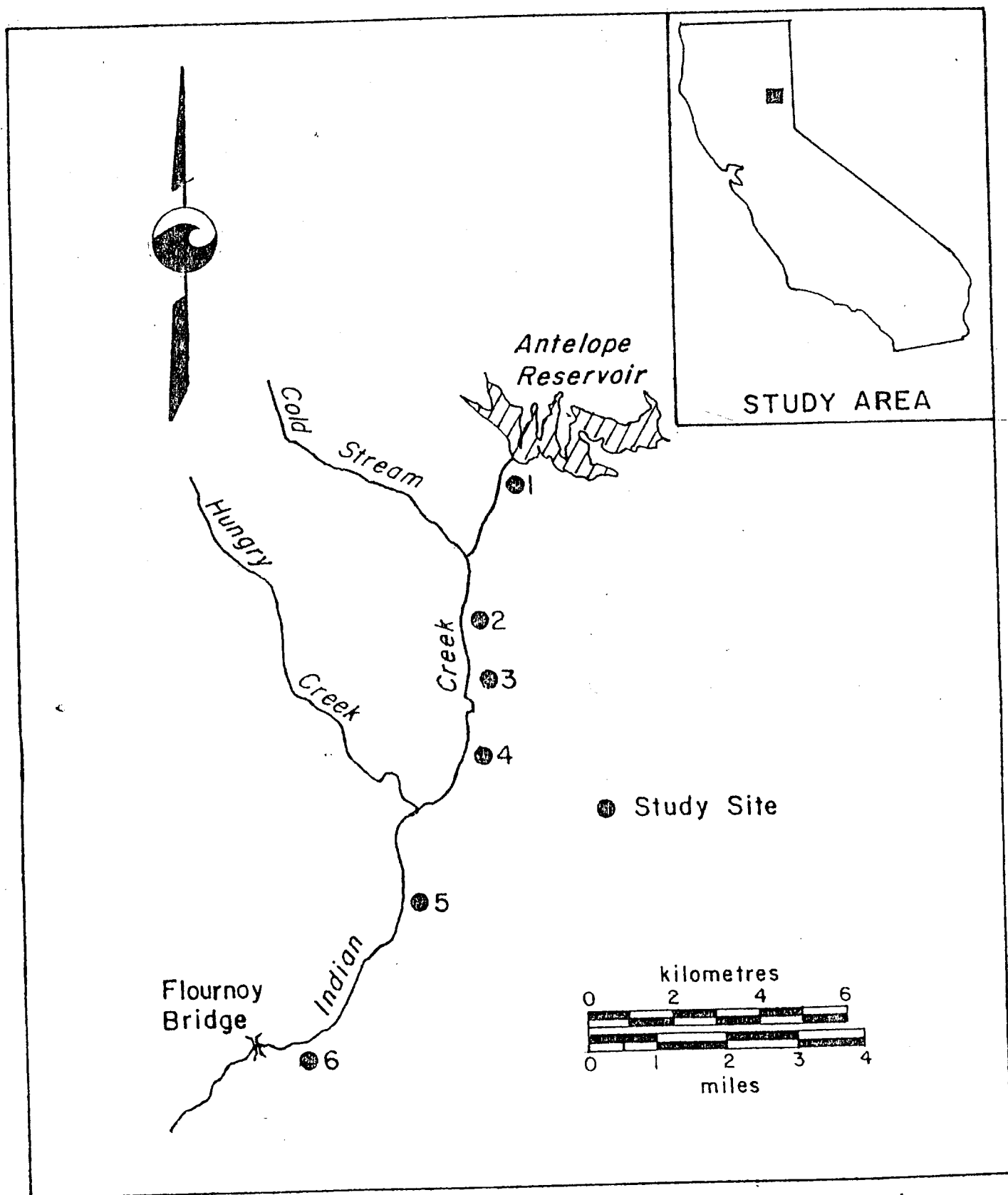


Figure 1 - Stations sampled to determine biomass of fishes in Indian Creek, Plumas County, September 1987

METHODS

Standing stocks of fishes were estimated at six stations in Indian Creek (Figure 1) in Plumas County. Stations were intentionally selected to be near stations sampled in previous DFG studies (Appendix 1). Markers had previously been placed in trees along the stream to identify station boundaries. Stations varied in length from 24.5 to 89 m. The length, average width, and average depth of each station was measured. Fish were captured with a battery-powered backpack electroshocker (Smith-Root, Type VII) in stream sections blocked by seines. Captured fish were removed from the net-enclosed section on each pass. Standing stock estimates were developed using the two-count method of Seber and LeCren (1967) or the multiple-pass method of Leslie and Davis (1939) with limits of confidence computed using a formula proposed by DeLury (1951).

The weights of brown trout, rainbow trout, Sacramento squawfish (Ptychocheilus grandis), and Sacramento sucker (Catostomous occidentalis) were determined by displacement. Weights were measured for all fish caught. Fork length of each fish caught was measured to the nearest millimeter.

Scale samples were taken from brown trout and rainbow over 100 mm in length. Scales were mounted dry between microscope slides, and their images were projected on a NCR microfiche reader at a magnification of 42x. Scale measurements for the calculation of growth were recorded to the nearest millimeter along the anterior radius of the anterior-posterior axis of the scale.

Geometric mean functional regressions were used to describe the body-scale and length-weight relationships (Ricker, 1975). Estimation of true mean growth rate (G) was calculated using methods of Ricker (op. cit.).

Distribution of all fish caught is listed according to location. Standing crops of brown trout and rainbow trout were calculated for individual stations where the species of interest were caught and combined for the entire creek. Age and growth was calculated for the population. Mean individual growth was calculated only for brown trout and rainbow trout. Length-weight relationships were determined for brown trout and rainbow trout in Indian Creek. The coefficient of condition and 95% confidence intervals were calculated for both brown trout and rainbow trout.

RESULTS

Distribution

Brown trout were caught at all six stations. Rainbow trout were caught at every station except station 4. Sacramento squawfish and Sacramento suckers were caught only at station six (Table 1).

TABLE 1. Distribution of Fishes in Sections of Indian Creek, Plumas County, 1987

	Station Number					
	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>	<u>6</u>
Distance below Antelope Dam (km)	0.6	3.9	5.3	6.8	12.3	21.0
Brown trout	X	X	X	X	X	X
Rainbow trout	X	X	X		X	X
Sacramento squawfish						X
Sacramento sucker						X

Standing Crop

Brown trout were the most common game fish caught in Indian Creek. Biomass averaged 3.9 g/m^2 at six stations. Biomass for brown trout large enough for fishermen to catch and keep (127 mm FL) averaged 2.9 g/m^2 (Table 2). Rainbow trout biomass averaged 2.1 g/m^2 , while the biomass for catchables averaged 2.6 g/m^2 (Table 3).

Sacramento squawfish were the most common non-salmonid fish caught in Indian Creek. Biomass averaged 0.37 g/m^2 for Sacramento squawfish and 0.18 g/m^2 for Sacramento sucker (Table 4).

Age and Growth

The formula $L = 16.0 + 4.19 S$ describes the relationship between the fork length (L) and enlarged scale radius (S) of 87 brown trout caught in Indian Creek. The coefficient of correlation (r^2) is 0.85. The formula was $L = 35.8 + 4.13 S$ for 37 rainbow trout caught in Indian Creek, while the value for r^2 is 0.72.

Growth rates for 2+ brown trout were faster than age 1+ in both population growth rate and mean individual growth rate. Population growth was faster in both 1+ and 2+ than for mean individual growth (Table 5).

Age 1+ rainbow trout had faster growth rates for population and mean individual growth than did age 2+ rainbow trout (Table 6).

TABLE 2. Estimate of Brown Trout Standing Crop in Indian Creek, Plumas County, 1987

Distance Below Antelope Dam (km)	Population Estimate	95% Confidence Interval	Biomass g/m	Estimate of Catchable Trout (127 mm FL)	Biomass of Catchable Trout g/m
0.6	1	1-1	0.63	1	0.63
3.9	61	5-117	3.4	2	1.5
5.3	113	96-130	9.8	14	8.1
6.8	72	71-73	3.6	5	2.1
12.3	54	40-68	1.7	2	0.68
21.0	2	2-2	4.3	2	4.3

TABLE 3. Estimates of Rainbow Trout Standing Crop in Indian Creek, Plumas County, 1987

Distance Below Antelope Dam (km)	Population Estimate	95% Confidence Interval	Biomass g/m	Estimate of Catchable Trout (127 mm FL)	Biomass of Catchable Trout g/m
0.6	2	2	0.11	1	0.11
3.9	1	1	0.37	1	0.37
5.3	2	2	0.04	-	-
12.3	6	4-8	0.28	3	0.27
21.0	8	8	9.6	8	9.6

TABLE 4. Estimates of Standing Crop of Nongame Fishes in Indian Creek, Plumas County, 1987

Distance Below Antelope Dam (km)	Species	Population Estimate	95% Confidence Interval	Biomass g/m ²
21.0	Sacramento squawfish	6	6-6	0.37
21.0	Sacramento sucker	2	2-2	0.18

TABLE 5. Growth Rates for Brown Trout Caught in Indian Creek, Plumas County, 1987

Age Interval	Population Growth			Mean Individual Growth		
	Length Interval (mm)	Difference of Natural Logarithms	Instantaneous Growth Rate Gx	Length Interval (mm)	Difference of Natural Logarithms	Instantaneous Growth Rate Gx
1-2	104-203	0.669	0.631	108-203	0.631	0.596
2-3	203-286	0.343	0.725	207-286	0.323	0.684

TABLE 6. Growth Rates for Rainbow Trout Caught in Indian Creek, Plumas County, 1987

Age Interval	Population Growth			Mean Individual Growth		
	Length Interval (mm)	Difference of Natural Logarithms	Instantaneous Growth Rate Gx	Length Interval (mm)	Difference of Natural Logarithms	Instantaneous Growth Rate Gx
1-2	114-229	0.698	0.896	118-229	0.663	0.851
2-3	229-328	0.359	0.645	237-328	0.325	0.584

Age 1+ brown trout averaged 254 mm in fork length; 2+ and 3+ fish averaged 280 and 334 mm, respectively (Table 7).

One 3+ rainbow trout was caught. This fish measured 372 mm in fork length. Age 1+ and 2+ fish measured 198 and 260 mm, respectively (Table 8).

TABLE 7. Calculated Fork Length in Millimetres of Brown Trout from Indian Creek, Plumas County, 1987

Age	No. of Fish	Length at Capture (mm)	Calculated Lengths at Successive Annuli		
			1	2	3
1	11	254	104	-	-
2	46	280	108	203	-
3	12	334	105	208	286
Number of back-calculations			69	58	12
Weighted means (mm)			107	204	286
Increments (mm)			107	97	82

TABLE 8. Calculated Fork Length in Millimetres of Rainbow Trout from Indian Creek, Plumas County, 1987

Age	No. of Fish	Length at Capture (mm)	Calculated Lengths at Successive Annuli		
			1	2	3
1	24	198	114	-	-
2	9	260	118	229	-
3	1	372	128	237	328
Number of back-calculations			34	10	1
Weighted means (mm)			115	230	328
Increments (mm)			115	115	98

Length and Weight

Age group 0+ brown trout represented 76% of the catch. Ages 1+ and 2+ fish represented 4% and 16%, respectively, while 3+ fish made up 4% (Figure 2).

Age group 0+ rainbow trout represented 19% of the catch. Ages 1+ and 2+ fish made up 57% and 21%, respectively, with 3+ making up the remaining 3% (Figure 3). (Appendices 2 and 3).

The relationship between length (L) and weight (W) of brown trout is:

$$\text{Log}_{10}W = -4.87 + 2.95 \text{ Log}_{10}L$$

$$r^2 = 0.98$$

$$N = 283 \text{ (Figure 4)}$$

The same relationship for rainbow trout is:

$$\text{Log}_{10}W = -4.91 + 2.98 \text{ Log}_{10}L$$

$$r^2 = 0.98$$

$$N = 30 \text{ (Figure 5)}$$

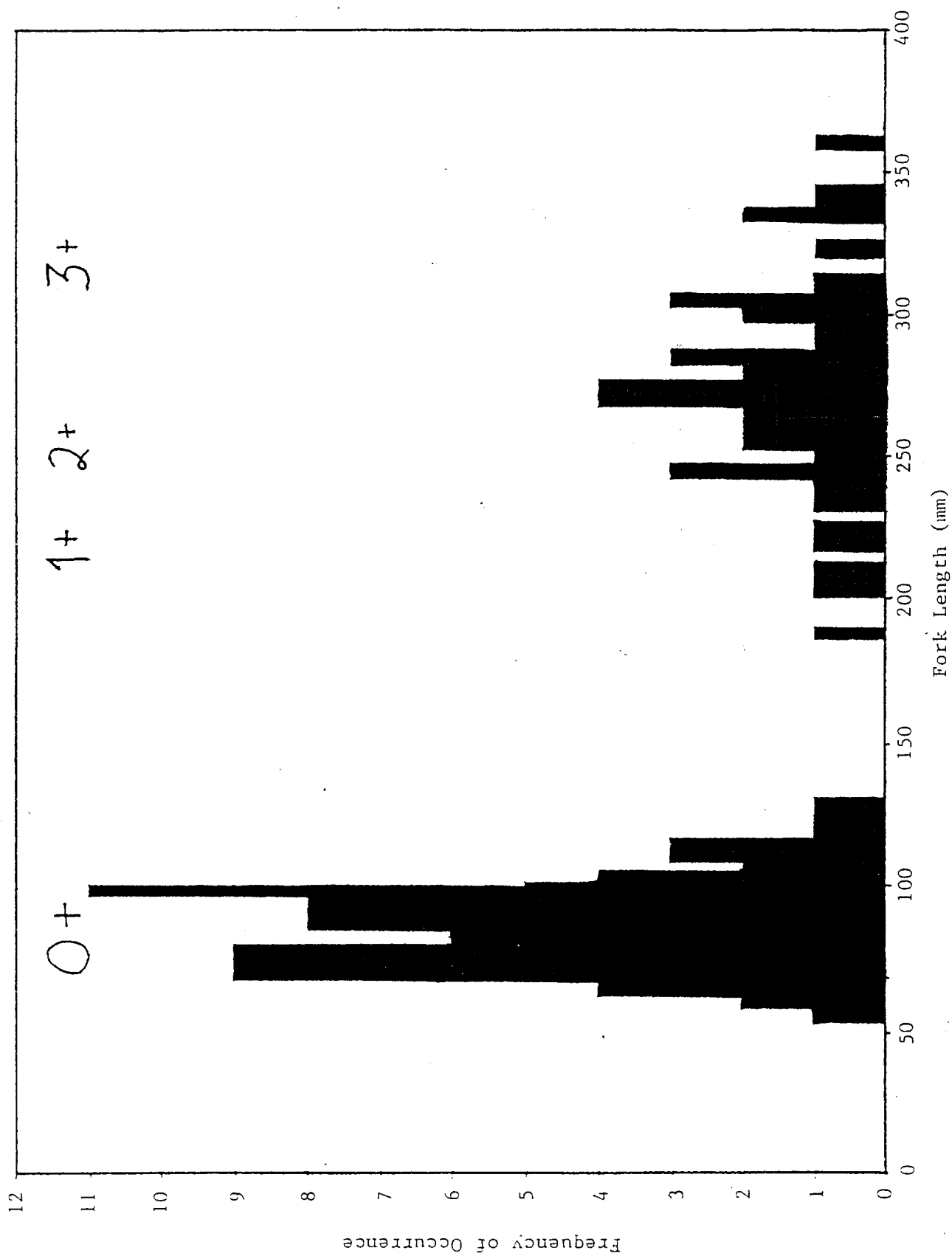


FIGURE 2 Length, observed frequency, and age of brown trout caught in Indian Creek, Plumas County, 1987.

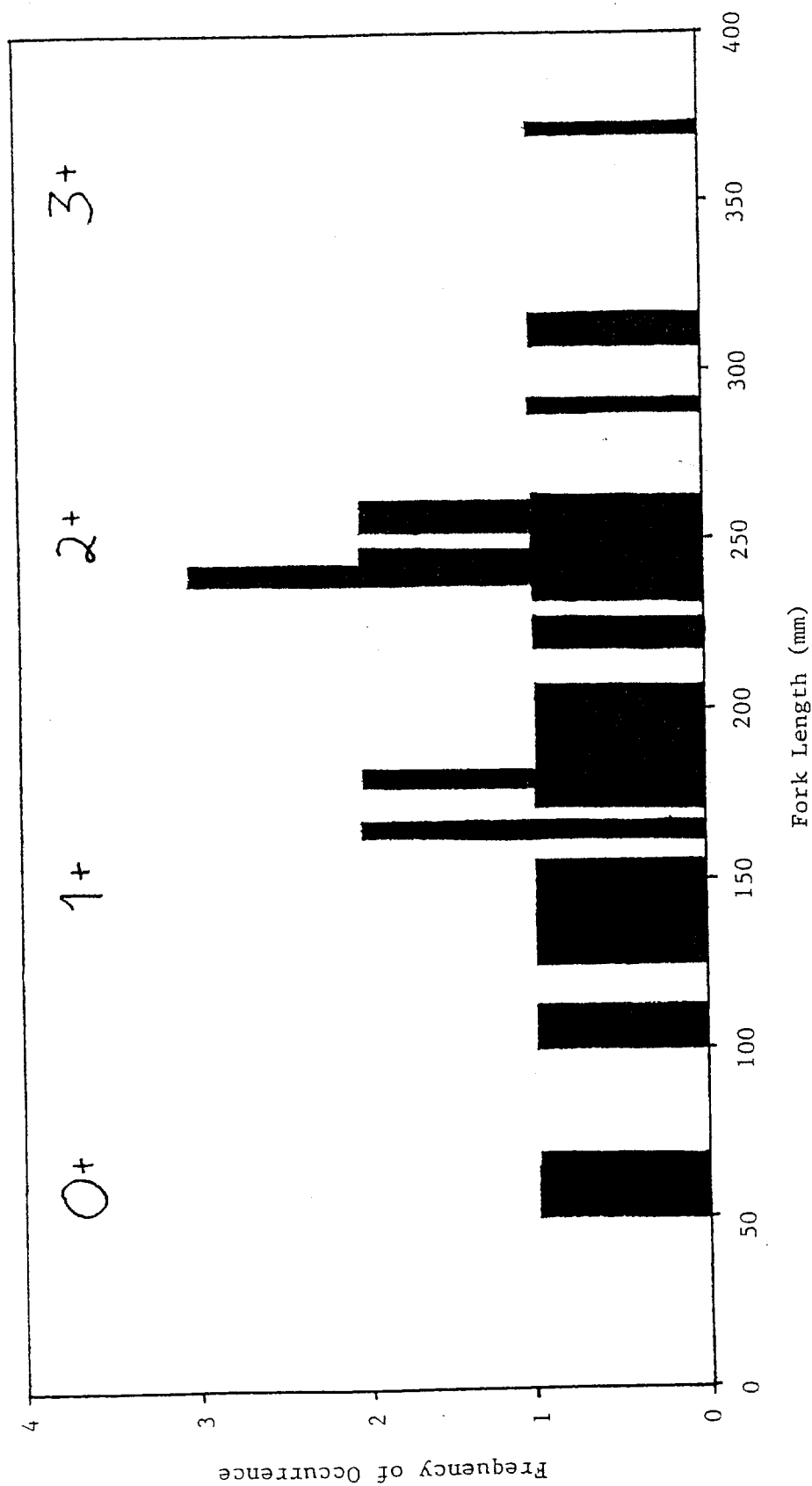


FIGURE 3 Length, observed frequency, and age of rainbow trout caught in Indian Creek, Plumas County, 1987.

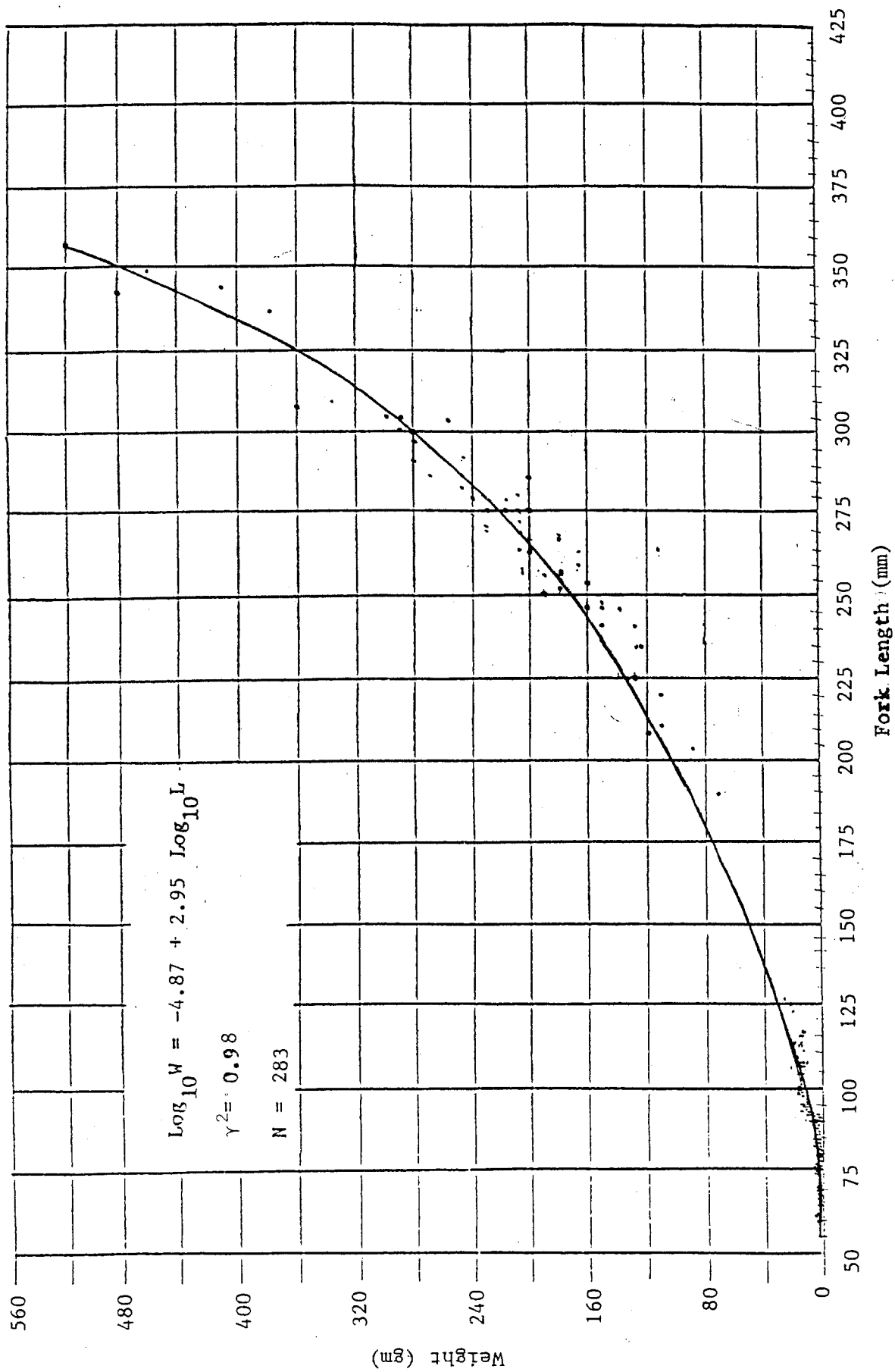


FIGURE 4 The relationship between length and weight of brown trout caught in sections of Indian Creek, Plumas County, 1987.

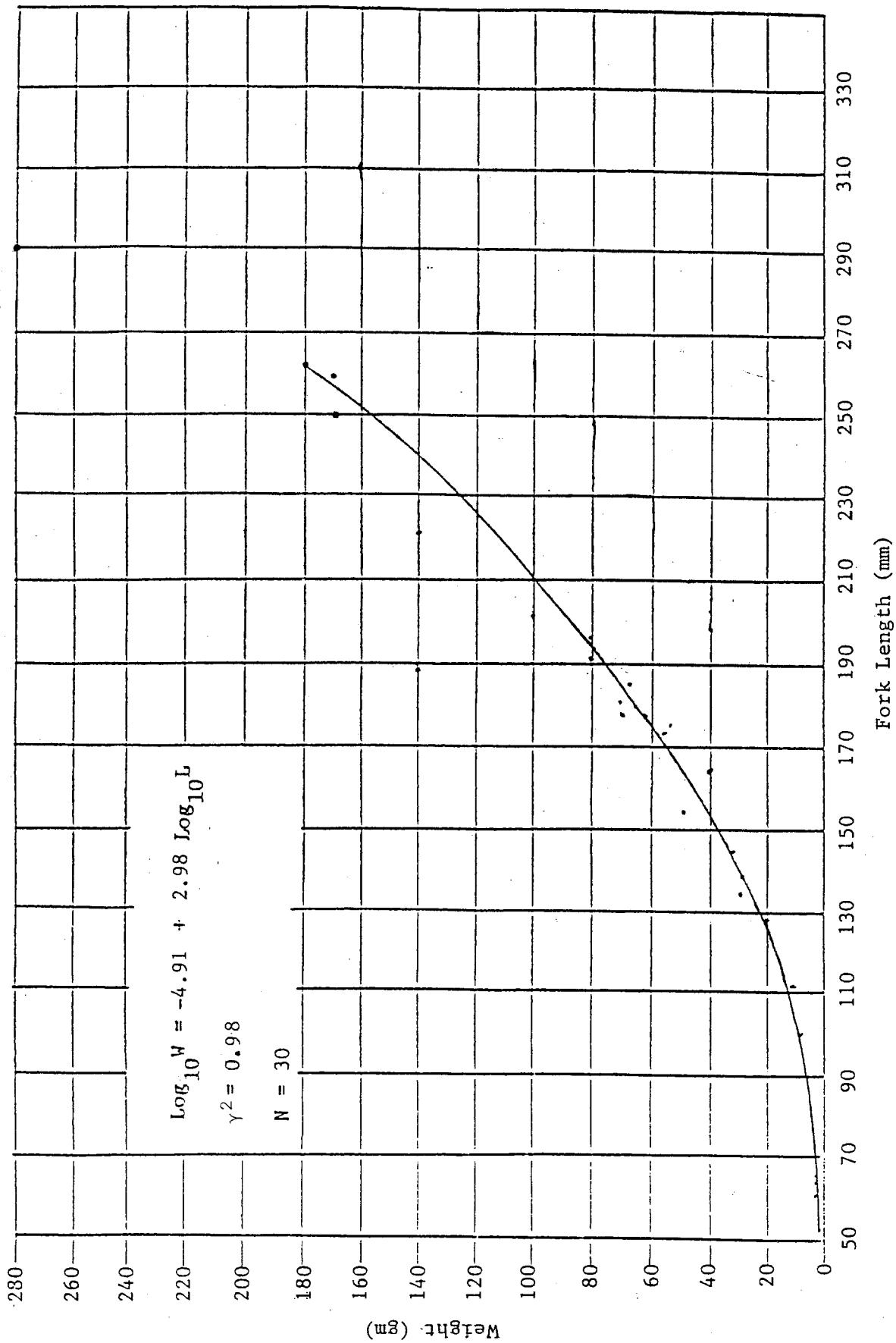


FIGURE 5 The relationship between length and weight of rainbow trout caught in sections of Indian Creek, Plumas County, 1987.

Coefficient of Condition

We calculated the coefficient of condition and 95% confidence limits for a total of 283 brown trout and 30 rainbow trout (Table 9). There is no significant difference between the coefficient of condition for any age group of brown trout or rainbow trout we tested ("t" test, 0.05 level).

TABLE 9. Condition of Brown Trout and Rainbow Trout in Indian Creek, Plumas County, 1987

Age Group	Number of Fish	Coefficient of Condition	95% Confidence Interval
Brown trout			
0+	211	1.1056	0.8136-1.3976
1+	10	1.1171	0.9541-1.2801
2+	39	1.0574	0.8724-1.3424
3+	7	1.0693	0.8883-1.2503
Combined*	283	1.0938	0.8188-1.3688
Rainbow trout			
0+	8	1.0809	0.7779-1.3839
1+	18	1.1652	0.6802-1.6502
2+	3	1.0130	0.8070-1.2190
3+	1	1.0295	1.0295-1.0295
Combined	30	1.1225	0.6965-1.5485

* We were unable to age sixteen brown trout from scale samples, but they were included in the combined coefficient of conditions and 95% confidence interval.

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APPENDIX 1

PERMANENT FISH POPULATION STATIONS
FOR INDIAN CREEK, PLUMAS COUNTY
SEPTEMBER AND OCTOBER 1987

APPENDIX 1

PERMANENT FISH POPULATION STATIONS INDIAN CREEK, PLUMAS COUNTY SEPTEMBER AND OCTOBER 1987

Indian Creek has had two periods of very high runoff (late May 1983 and mid-February 1986), since fish populations were last sampled in September 1982. High flows during these periods severely eroded streambanks in meadow sections of the creek, toppled many trees into the creek, deposited large quantities of sand and gravel, and rerouted the stream channel in many locations. Thus, although three of the six stations sampled in 1986 and 1987 are the same locations sampled in previous years, none of the stations are truly comparable to those sampled in previous years. One of the new stations (6A) was picked because it appears to be similar to the station it replaced; the other two (3A and 4A) are quite different from the old stations but seem to represent typical habitat in those portions of the creek.

Station 1 - Located 0.6 stream km below Antelope Dam adjacent to the picnic area near the junction of Indian Creek Road and the spur road leading to the base of the dam (NE 1/4 of NE 1/4, Section 27, T27N, R12E). Although there is some erosion along the left bank, and evidence of a few inches of channel degradation, this station appears to be similar to 1978 and 1979 before beaver dams flooded the lower portion of the station. The station consists of a pool and run area (21%) between two riffles (79%). It is 89 m long and has a surface area of 570 m² and a volume of 148 m³ at 0.56 cms.

Station 2 - Located 4.7 below Antelope Dam, 1.9 km below Cold Stream, and about 13.3 km above Fournoy Bridge (SW 1/4 of SW 1/4, Section 34, T27N, R12E). The station is 27 m long, marked by a 36-cm-diameter alder (RB) and a 10-cm-diameter pine, both with metal disks now barely visible from the road. This station looks similar to previous years. It contains riffle (26%) and shallow pool (74%) areas. The station has a surface area of 213 m² and a volume of 55 m³ at 0.56 cms.

Station 3 - Located about 6.1 km below Antelope Dam, 1.3 km above Babcock Crossing, and 11.9 km above Fournoy Bridge (NW 1/4 of NW 1/4, Section 10, T26N, R12E). This station replaces one just downstream which has been eroded into a deep pool too lengthy to electrofish. The new station has three pools (38%) separated by short riffles areas (62%). There are several downed trees on the eroded LB. Unlike the station it replaces, this station has little shade. The new station is 65 m long and has a surface area of 338 m² and a volume of 88 m³ at 0.56 cms.

Station 4 - Located about 7.3 km below Antelope Dam, 0.1 km above Babcock Crossing, and 10.7 km above Fournoy Bridge (NW 1/4 of SW 1/4, Section 10, T26N, R12E). This new station is located about 0.1 m downstream from the previous station and about halfway between Babcock Crossing and a parking turnout 0.3 km upstream. The station contains two small pools (28%) separated by riffles areas (72%). Like the station it replaces, it is mostly unshaded. The station is 58 m long and has a surface area of 441 m² and a volume of 110 m³ at 0.56 cms.

Station 5 - Located at an unimproved campground about 12.0 km below Antelope Dam and 6.0 km above Flournoy Bridge (SW 1/4 of SW 1/4, Section 21, T26N, R12E). The station extends 74 m upstream from the lower end of a riffle area adjacent to the turnaround at the end of the paved access road (Transect 3 of the instream flow study). Metal disks remain on a small willow (LB) at the lower end of the station. The station contains a riffle and shallow run area, a large 0.8 m deep pool with undercut bank (RB), and a shallow riffle area. Riffle area is 74%, pool area 26%. The station was greatly modified this summer by gold-dredging activities of United Prospectors, Inc. Recreational miners deepened undercut banks, dug numerous pits, and left scattered piles of rubble. The station has a surface area of 525 m² and a volume of 142 m³ at 0.56 cms.

Station 6 - Located about 1.0 km above Flournoy Bridge and about 17.0 km below Antelope Dam (NE 1/4 of SW 1/4, Section 31, T26N, R12E). (Drive 0.3 km east of Flournoy Bridge on the Indian Creek road and take the paved spur road to the right 0.6 km to a gate in the fence on the right side of the road where the creek turns south from the road. Follow a trail along the streambank downstream about 35 m.) The lower end of the station is located at a steep rapid at the lower end of the alders where the streambed widens abruptly. The new station is located just upstream of the original station, which was greatly changed by the February 1986 flood. The station is a rocky run with several small pockets of slow water and undercut bank on RB. Riffle area totals 100% and pool area 0%. The station is 24.5 m long with a surface area of 130 m² and a volume of 30 m³ at 0.56 cms.

APPENDIX 2

LENGTH AND WEIGHT OF BROWN TROUT
CAUGHT IN INDIAN CREEK, 1987^a

APPENDIX 2

LENGTH AND WEIGHT OF BROWN TROUT CAUGHT IN INDIAN CREEK, SEPTEMBER 1987

Length (mm)	Weight (g)	Length (mm)	Weight (g)
55	2	98	9,10,10,
60	2,3		11,11,11,11
62	4	99	9,9,11,11,11,
63	3		11,11,11,11,
64	3,3,3,4		12,12
65	2,3,3,3	100	10,11,11,13,13
66	3,3,3	101	10,11
67	3,4	102	11,12,12,13
68	3,3,4,4	103	11,12
69	3,4	104	11,11,12,13
70	3,3,3,4,4,	106	11,12
	4,4,4,4	107	14
71	3,4,4,4,4	108	14
	4,4,4,4	109	14,15
72	4,4,4,5	110	13
73	4,4,4,4	112	11,14,14
74	4,4,4,5	113	13,17
75	4,5,5,5,5	114	17,17
76	5,5,5,5,6	115	15,16,16
77	6	117	18
78	4,5,5,5,5,	118	17
	6,6,6,7	119	18
79	6,6,6,6,6	123	20
80	5,5,6,6,6,7	125	23
81	5,6,6,7	129	23
82	6,7,7,7,8,8	189	70
83	6,6,6,6,7	204	90
84	6,6,7,8	210	120
85	6,7,7	212	110
86	7,7,7	220	100
87	7,7,7,7,7,	225	130
	8,8,9	234	130
88	7,7,8,8	235	125
89	7,7,8	239	150
90	6,7,8,8,8,	240	130
	9,9	245	140,150,160
91	8,8	247	150
92	8,8,8,8,9,9	250	190
93	8,8,8,8,	253	180
	9,9,11	255	160,160
94	8,9,9,9,9,	256	180,190
	9,10,10	257	180,210
95	9,10	258	210
96	9	260	170,190

APPENDIX 2 (cont'd.)

LENGTH AND WEIGHT OF BROWN TROUT CAUGHT IN INDIAN CREEK, SEPTEMBER 1987

<u>Length</u> <u>(mm)</u>	<u>Weight</u> <u>(g)</u>	<u>Length</u> <u>(mm)</u>	<u>Weight</u> <u>(g)</u>
265	170,200	285	200,250,270
266	210	290	280
268	200	291	250
269	110,180	295	280
270	180,210,210,	300	280,290
	230	305	260,290,300
272	230	310	360
273	210	313	340
274	240	324	360
275	200,210,220,	335	380,420
	230	340	480
279	220,230	341	410
280	240	344	460
282	210	360	520
284	250		

APPENDIX 3

LENGTH AND NUMBER OF BROWN TROUT
CAUGHT IN INDIAN CREEK, 1987-

APPENDIX 3

LENGTH AND NUMBER OF BROWN TROUT CAUGHT IN INDIAN CREEK, 1987

<u>Length</u> <u>(mm)</u>	<u>Number</u> <u>(g)</u>	<u>Length</u> <u>(mm)</u>	<u>Number</u> <u>(g)</u>
55	1	106	2
60	2	107	1
62	1	108	1
63	1	109	2
64	4	110	1
65	4	112	3
66	3	113	2
67	2	114	2
68	4	115	3
69	2	117	1
70	9	118	1
71	9	119	1
72	4	123	1
73	4	125	1
74	4	129	1
75	5	189	1
76	5	204	1
77	1	210	1
78	9	212	1
79	5	220	1
80	6	225	1
81	4	234	1
82	6	235	1
83	5	239	1
84	4	240	2
85	3	245	3
86	3	247	1
87	8	250	1
88	4	253	1
89	3	255	2
90	7	256	2
91	2	257	2
92	6	258	1
93	7	260	4
94	8	265	3
95	2	266	1
96	1	268	1
98	7	269	2
99	11	270	7
100	5	272	1
101	2	273	1
102	4	274	1
103	2	275	4
104	4	279	2

APPENDIX 3 (cont'd.)

LENGTH AND NUMBER OF BROWN TROUT
CAUGHT IN INDIAN CREEK, 1987

<u>Length</u> <u>(mm)</u>	<u>Number</u> <u>(g)</u>	<u>Length</u> <u>(mm)</u>	<u>Number</u> <u>(g)</u>
280	1	313	1
282	1	315	1
284	1	320	1
285	3	324	1
290	3	325	1
291	1	335	2
295	1	340	1
300	2	341	1
305	3	344	1
310	2	360	2

APPENDIX 4

LENGTH AND WEIGHT OF RAINBOW TROUT
CAUGHT IN INDIAN CREEK, 1987

APPENDIX 4

LENGTH AND WEIGHT OF RAINBOW TROUT CAUGHT IN INDIAN CREEK, 1987

<u>Length</u> <u>(mm)</u>	<u>Weight</u> <u>(g)</u>	<u>Length</u> <u>(mm)</u>	<u>Weight</u> <u>(g)</u>
53	2	176	62
61	3	177	70
65	3	180	64,70
67	3	185	68
102	10	189	140
111	13	191	80
129	20	198	80
135	27	203	100
140	29	222	140
145	32	250	170
154	50	260	170
165	40, 40	262	180
174	55	290	280
175	52	372	530

APPENDIX 5

LENGTH AND NUMBER OF RAINBOW TROUT
CAUGHT IN INDIAN CREEK, 1987

APPENDIX 5

LENGTH AND NUMBER OF RAINBOW TROUT CAUGHT IN INDIAN CREEK, 1987

<u>Length</u> <u>(mm)</u>	<u>Number</u> <u>(g)</u>	<u>Length</u> <u>(mm)</u>	<u>Number</u> <u>(g)</u>
53	1	189	1
61	1	191	1
65	1	198	1
67	1	203	1
102	1	205	1
111	1	222	1
129	1	225	1
135	1	235	1
140	1	240	3
145	1	245	2
154	1	250	1
165	2	255	2
174	1	260	2
175	1	262	1
176	1	290	1
177	1	310	1
180	2	315	1
185	1	372	1

APPENDIX 6
METRIC CONVERSION FACTORS

APPENDIX 6

METRIC CONVERSION FACTORS

<u>Quantity</u>	<u>Metric Units</u>	<u>Divide by</u>	<u>English Units</u>
Length	millimetres (mm)	25.4	inches (in)
	centimetres (cm)	2.54	inches (in)
	metres (m)	0.3048	feet (ft)
	kilometres (km)	1.6093	miles (mi)
Area	square metres (m ²)	0.0929	square feet (ft ²)
Volume	cubic metres (m ³)	0.7646	cubic yards (yd ³)
Flow	cubic metres per second (cms)	0.0283	cubic feet per second (cfs)
Biomass	grams per square metre (g/m ²)	8.92	pounds per acre (lb/acre)